PATHFINDER

HUMANS IN SPACE

Technology for NASA Future Missions an AIAA/NASA OAST Conference

September 12-13, 1988 The Capital Hilton Washington, DC

JOHN L ANDERSON HUMANS IN SPACE PROGRAM INTEGRATOR

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PRECEDING PACE BLANK WOD FILMEN

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HUMAN EXPLORATION OF THE SOLAR SYSTEM

MISSION CONDITIONS

- O DURATION INCREASE OF AN ORDER OF MAGNITUDE
- O UNACCUSTOMED ENVIRONMENTAL STRESS FROM:
 - * SMALL GROUP, CONFINED ISOLATION
 - * UNFAMILIAR RISKS
 - * SPACE RADIATION
 - * UNNATURAL GRAVITY FIELDS
- O TOTAL, UNRELIEVED DEPENDENCE ON ADVANCED TECHNOLOGICAL SYSTEMS

HUMAN EXPLORATION OF THE SOLAR SYSTEM

HUMAN SELF-SUFFICIENCY

- O ON PAST MISSIONS, FLIGHTS HAVE BEEN SHORT, ACTIVITIES NEW AND CHALLENGING, AND RESOURCES EXPENDABLE
 - * PERFORMANCE REQUIREMENTS HAVE FALLEN WITHIN EASY REACH OF HUMAN VERSATILITY AND SHORT-TERM ADAPTABILITY
 - * SUPPORT REQUIREMENTS HAVE FALLEN WITHIN OUR TRANSPORT CAPABILITY
- O BUT FOR MUCH LONGER MISSIONS:
 - * HUMANS MUST FUNCTION OUTSIDE THE BOUNDARIES OF THE CURRENTLY KNOWN PERFORMANCE ENVELOPE
 - * LIFE SUPPORT RESOURCES MUST BE REGENERATED

RATIONALE

- O EXISTING TECHNOLOGIES MAY NOT BE SCALABLE TO MEET HUMAN PERFORMANCE AND SUPPORT REQUIRMENTS OVER LONG, SELF-SUFFICIENT MISSIONS
- O TECHNOLOGY IDENTIFICATION AND ADVANCEMENT CANNOT EFFECTIVELY PROCEED INDEPENDENTLY FROM THE DETERMINATION OF THE HUMAN REQUIREMENTS

PATHFINDER / HUMANS IN SPACE

JOINT PROGRAM

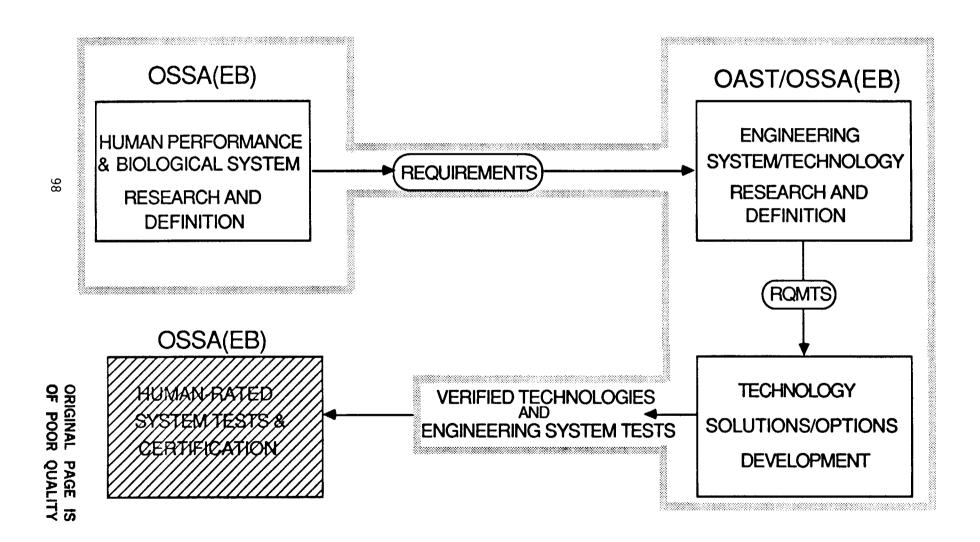
OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY
OFFICE OF SPACE SCIENCE AND APPLICATIONS
(LIFE SCIENCES DIVISION)

OBJECTIVES

Determine the enabling system engineering and technology requirements and develop technology options

Determine critical human and system performance requirements for enabling human health, productivity and self-sufficiency

PATHFINDER/HUMANS-IN-SPACE TECHNICAL REQUIREMENTS INTERFACES



HUMANS IN SPACE - FUNCTIONAL OBJECTIVES

ENABLE: ON-DEMAND, EXTENDED DURATION SURFACE EVA

WITH ON-SURFACE SUIT MAINTENANCE AND ECLSS

REGENERATION

ENABLE: PRODUCTIVE COGNITIVE, PHYSICAL, BEHAVIORAL,

AND TEAM PERFORMANCE THROUGHOUT MISSIONS

OF UNACCUSTOMED ENVIRONMENTAL STRESS AND

DEPENDENCE ON TECHNOLOGICAL SYSTEMS

ENABLE: A MEANS TO MAINTAIN HEALTH AND PHYSICAL

CONDITIONING DURING LONG EXPOSURE TO

UNNATURAL GRAVITY FIELDS AND SPACE RADIATION

ENABLE: LIFE SUPPORT SYSTEM SELF-SUFFICIENCY AND

SIGNIFICANT REDUCTION IN EXPENDABLES WEIGHT &

TRANSPORT REQUIREMENTS FOR MISSIONS > 1 YR

EVA/Suit

Integrated Systems Tests Completed

Prototypes Ground-Validated

EVA & Serv. Syst. Components and Subsystems Validated

Integrated Systems Technology Demonstrator Completed

End Effector & Glove Validated

2000

Biomedical Rqmts Defined

Space Serviceable EVA System Concepts Analyzed

Critical Components Developed

PLSS / Heat-Refrig System
Proof-of-Concept Demonstrated

HUMAN PERFORMANCE HUMAN-MACHINE INTERACTIONS

Human Performance Models Scientifically Validated

Human-Machine Interface Technology Validated

Prototype Human-Automation-Robotics System Tests Completed

Model-Based CAD Habitat Design Capability Developed

Human-Automation-Robotics

Countermeasures for Human-Machine Performance Decrement Identified 2000

Cognitive & Physical Perform. Models Developed

101

Human-Machine System Design Tools Developed (CAD)

Human-Automation-Robotics System Reqmts. Determined

1996

Integrated System Test Bed Operational

HUMAN
PERFORMANCE
ARTIFICIAL GRAVITY
HUMAN FACTORS
RADIATION

Radiation Shielding Rqmts.

Artificial Gravity Rqmts.

Habitability Rqmts.

Selection, Training, Crew Factors & Mission Rqmts.

Ongoing Tests to Determine
Operational and Structural
Parameters of Art.-G Systems

2000

Ongoing Tests to Determine Crew Factor and Habitability Parameters

Prelim. Ramts Determ. for Art-G

- Chronic Rotation Tolerance
- Feasibility of Acute-G Loading

Partial-G Load Ground Test Facility Completed

Prelim. Shielding Rqmts for Space Radiation Defined

Analog Environ. Operational

CLOSED LOOP LIFE SUPPORT PHYSICAL-CHEMICAL

Full Scale Integrated P-C System Tests Complete

Engineering Design of Integrated P-C / Biol. System

2000

Proc & Subsys Models Integrated and Tech. Validated in Test Bed

Power, Thermal, Fluid Subsyst. Integration Concepts Defined

P-C Eng. System Designed

Integrated P-C / Biol.
System Concepts Defined

Chem. Process Models Compl.

Chem. Process Tests Underway

Prelim. Rqmts for Monitoring & Control Determined

1996

CLOSED LOOP LIFE SUPPORT BIOREGENERATIVE

Integrated Bioregenerative System Tests Complete

Initial Tests Conducted in Human-Rated Test Facility Complete Model of Integrated System Behavior & Control

2000

Define Bioregen. System with Advanced P/C Subsystems

Define Mission-Specific Bioregen. System Concepts

Feasibility of Bioregenerative Concept Demonstrated in Breadboard Facility

104

Analytical Process & System Models Developed

Complete Initial Studies of Human-Rated Test Facility

PATHFINDER HUMANS IN SPACE

PROGRAM MANAGEMENT

O OAST DIVISIONS:

105

* DIRECTORATE FOR SPACE

* PROPULSION, POWER & ENERGY

* INFORMATION SCIENCES AND

HUMAN FACTORS

* MATERIALS AND STRUCTURES

OSSA LEAD DIVISION: * LIFE SCIENCES DIVISION

- O NASA FIELD CENTERS:
 - * AMES RESEARCH CENTER
 - * JOHNSON SPACE CENTER
 - * KENNEDY SPACE CENTER
- O FY 1989 BUDGET: \$6.0 M
- O FY 90-94 TOTAL BUDGET: \$227.5 M

SUMMARY

- O EXPANSION OF HUMAN PRESENCE INTO THE SOLAR SYSTEM WILL REQUIRE:
 - * DETERMINATION OF HUMAN RESPONSE TO MISSION CONDITIONS
 - * DETERMINATION OF HUMAN REQUIREMENTS FOR WELL-BEING AND PRODUCTIVITY
 - * DEVELOPMENT AND VALIDATION OF TECHNOLOGICAL SOLUTIONS (BIOMEDICAL AND ENGINEERING) TO MEET THE HUMAN AND MISSION REQUIREMENTS
- O PROPOSED PATHFINDER PROGRAM WILL:
 - * IDENTIFY THE MOST CRITICAL UNCERTAINTIES IN HUMAN AND TECHNOLOGICAL REQUIREMENTS
 - * RESOLVE THEM TO THE DEGREE POSSIBLE
 - * WHERE APPROPRIATE, DEVELOP TECHNOLOGY SOLUTIONS